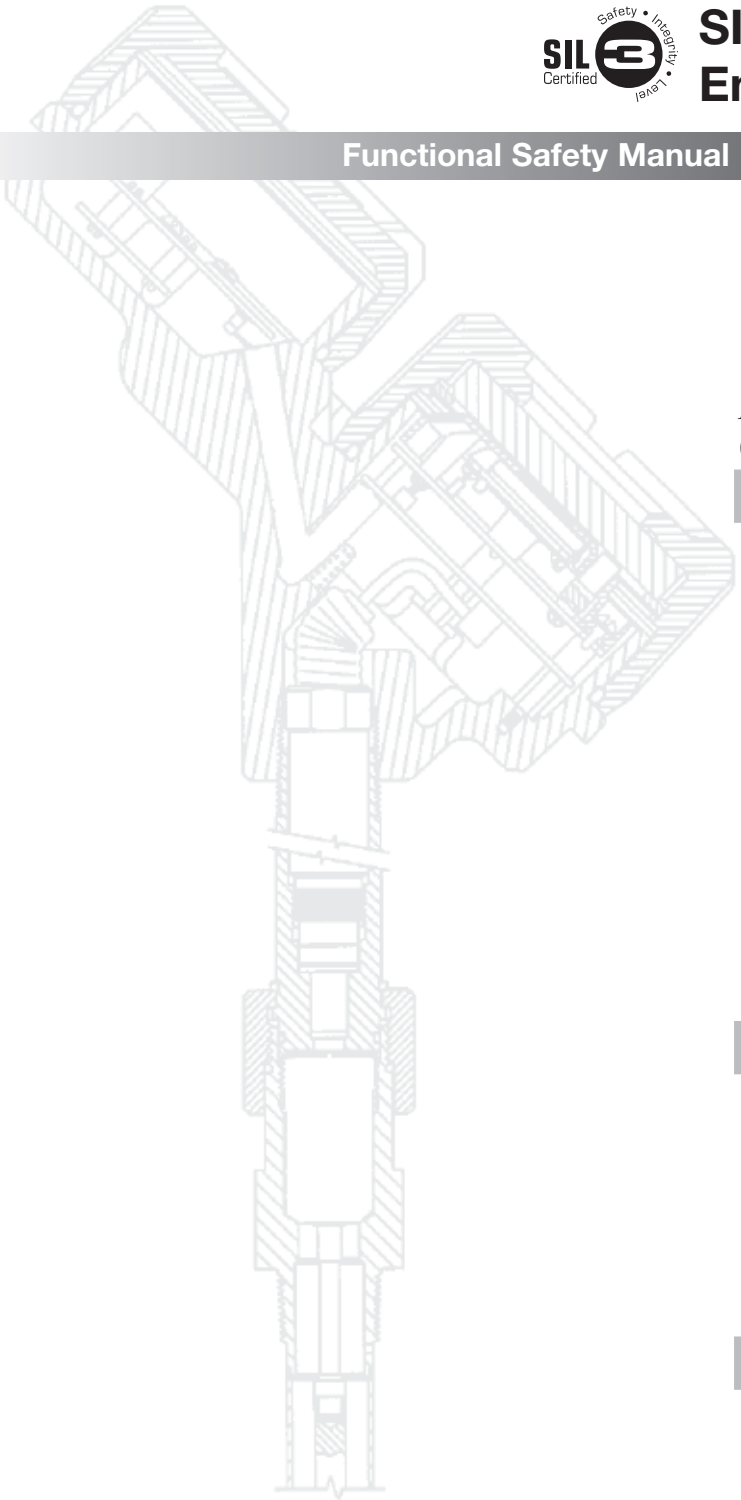
ECLIPSE®

SIL Certified Safety Manual for Enhanced Model 705-51AX-XXX

Software v3.x

Functional Safety Manual



Guided Wave Radar Level Transmitter

This manual complements and is intended to be used with the Eclipse® Enhanced Model 705 Installation and Operating manual (Bulletin 57-600 dated August 2005 or later).

Safety Function

The HART® version of the Eclipse® Enhanced Model 705 Guided Wave Radar (GWR) transmitter will measure level and transmit a signal proportional to that level within the stated safety accuracy of ±2% of span or the measured error published in I/O Manual 57-600, whichever is greater. In addition, when continuous, automatic diagnostics detect that the transmitter cannot perform this function, the output will be driven to the customer-specified out-of-range signal (i.e., less than 3.8 mA or greater than 20.5 mA).

The Enhanced Model 705 is certified for use in low demand level measurement applications.

Application

The Enhanced Model 705 Guided Wave Radar level transmitter can be applied in most process or storage vessels, bridles, and bypass chambers up to the probe's rated temperature and pressure. The Enhanced Model 705 can be used in liquids, slurries or solids to meet the safety system requirements of IEC 61508/IEC 61511-1.

Benefits

- Level protection to SIL 3 as certified by exida Certification per IEC 61508/IEC 61511-1.
- Probe designs to +800° F (+427° C), 6250 psig (430 bar) and full vacuum
- Cryogenic applications to -320° F (-190° C)
- IS, XP and Non-Incendive approvals
- Ability to measure reliably to the very top of the vessel. (Meets TÜV: WHG 19 overfill specifications when used with Model 7xD, 7xG, 7xR, and 7xT probes).

Magnetrol®

Eclipse® Enhanced Model 705 Guided Wave Radar Level Transmitter

SIL Certified Safety Manual for Enhanced Model 705-51AX-XXX

Table of Contents

1.0 Introduction

1.1 Theory of Operation

Guided Wave Radar is based upon the principle of TDR (Time Domain Reflectometry). TDR utilizes high frequency pulses of electromagnetic energy transmitted down a probe.

When a pulse reaches a surface that has a higher dielectric than the air/vapor in which it is traveling, the pulse is reflected. An ultra high-speed timing circuit precisely measures the transit time and provides an accurate level measurement.

1.2 Product Description

The Enhanced ECLIPSE Model 705 is a loop-powered, 24 VDC level transmitter using GWR technology.

For Safety Instrumented Systems usage, the 4–20 mA analog output is the safety variable. The analog output meets the requirements of NAMUR NE 43 (3.8 mA to 20.5 mA usable). The transmitter contains continuous self-diagnostics, and upon internal detection of a failure, is programmed to send its output to a user-selected failure state, either low or high. This failsafe state is defined as the Faulted Mode.

Table 1 shows the version of the ECLIPSE Enhanced Model 705 transmitter that has been certified for SIL 2/3 protection.

The Enhanced ECLIPSE Model 705 is classified as a Type B Device as defined by IEC61508.

Table 1
Enhanced ECLIPSE Model Numbers

1	**Transmitters:** **Model 705, 705-51A*-*** (HART)** **NOTE: All transmitters shipped after August 18, 2010 (serial numbers 667050-01-001 and later) are certified.**
2	**Probes:** **All ECLIPSE probes can be utilized. Refer to I/O Manual 57-600 for complete probe offering.**

1.3 Determining Safety Integrity Level (SIL)

Safety Instrumented System designers using the Enhanced ECLIPSE Model 705 must verify their design per applicable standards, including IEC 61511-1.

Three limits must be met to achieve a given SIL level:

1. The PFD_{AVG} numbers for the entire Safety Instrumented Function (SIF) must be calculated. Table 2 shows the relationship between the Safety Integrity Level (SIL) and the Probability of Failure on Demand Average (PFD_{AVG}).
2. Architecture constraints must be met for each subsystem. Table 3 can be used to determine the achievable SIL as a function of the Hardware Fault Tolerance (HFT) and the Safe Failure Fraction (SFF) for each subsystem in a safety system (Type B–complex components as per IEC 61508 Part 2) of which the level transmitter is just one component.

Table 2
SIL vs. PFD_{AVG}

Safety Integrity Level (SIL)	Target Average probability of failure on demand (PFD_{AVG})
4	$\geq 10^{-5}$ to $<10^{-4}$
3	$\geq 10^{-4}$ to $<10^{-3}$
2	$\geq 10^{-3}$ to $<10^{-2}$
1	$\geq 10^{-2}$ to $<10^{-1}$

Table 3
Minimum hardware fault tolerance
Type B sensors, final elements and non-PE logic solvers

SFF	Hardware Fault Tolerance (HFT)		
	0	1	2
None: <60%	Not Allowed	SIL 1	SIL 2
Low: 60% to <90%	SIL 1	SIL 2	SIL 3
Medium: 90% to <99%	SIL 2	SIL 3	
High: ≥99%	SIL 3		

3. All products chosen for use in the SIF must meet the requirements of IEC 61508 for the given SIL Capability level or be justified based on proven in use data collected for each job.

   The exSILentia tool from exida is recommended for design verification. This automatically checks all three limits and displays the results for any given design. The Enhanced ECLIPSE Model 705 is in the exSILentia database. This tool contains all needed failure rate, failure mode, SIL Capability and common cause data as well as suggested proof test methods.

2.0 Level Measuring System

Figure 1 shows the structure of a typical measurement system incorporating the Enhanced Magnetrol® Model 705 Guided Wave Radar transmitter.

This SIL 2/3 certified device is only available with an analog signal (4–20 mA) with HART digital communications. The measurement signal used by the logic unit must be the generated analog 4–20 mA signal proportional to level.

For fault monitoring, the logic unit must recognize both a high alarm (≥ 21.5 mA) and low alarm (≤ 3.6 mA).

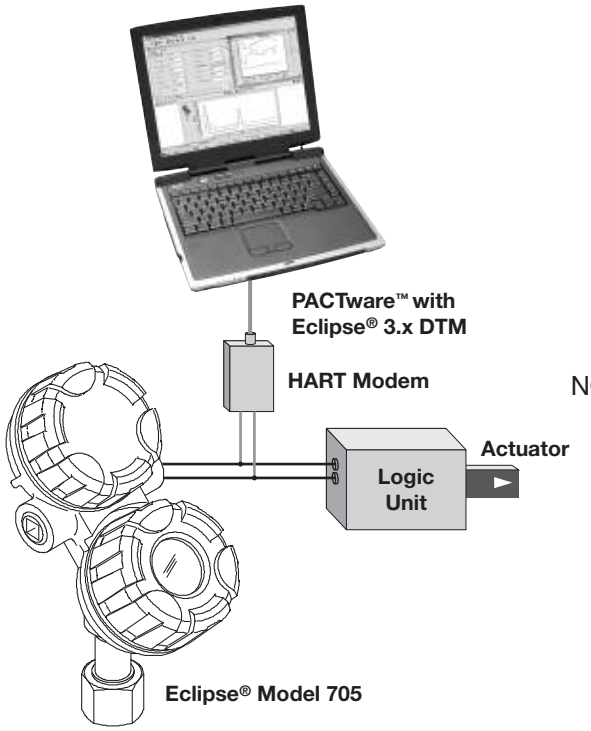


Figure 1
Typical System

NOTE: Care must be taken to ensure the loop continues to operate properly under a high alarm condition if the logic unit or loop contains intrinsic safety barriers.

The only unsafe mode is when the unit is reading an incorrect level within the 4–20mA range: ±2% of span or the measured error published in I/O Manual 57-600, whichever is greater. MAGNETROL defines a safe failure as one in which the 4–20 mA current is driven out of range (i.e., less than 3.8 mA or greater than 20.5 mA).

2.0.1 Digital Communication Protocols

Although the Enhanced ECLIPSE Model 705 transmitter is available with FOUNDATION Fieldbus™ and PROFIBUS digital communication outputs, HART is the only protocol included in the present IEC 61508/61511 standard.

2.1 Applicable Models

This manual is only applicable to the following Enhanced ECLIPSE Model 705 Guided Wave Transmitter:

705-51Ax-xxx (SIL 2, HFT 0)

2.2 Miscellaneous Electrical Considerations

The following are miscellaneous electrical issues that must be considered in any installation:

2.2.1 Pollution Degree 2

The Enhanced ECLIPSE Model 705 is designed for use in Category II, Pollution Degree 2 installations.

The usual pollution degree used for equipment being evaluated to IEC/EN 61010 is a nonconductive pollution of the sort where occasionally a temporary conductivity caused by condensation is expected.

2.2.2 Overvoltage

The Enhanced ECLIPSE Model 705 has over-voltage protection per the necessary CE requirements. As this protection is up to 1KV when considering Hi-pot, Fast Transients and Surge, no unsafe failure modes should exist up to this potential.

Overvoltage Category II is a local standard, covering appliances, portable equipment, etc., with smaller transient voltages than those characteristic of Overvoltage Category III. (This category applies from the wall plug to the power-supply isolation barrier or transformer).

The typical industrial plant environment is Overvoltage Category II, therefore, most equipment evaluated to the requirements of IEC/EN 61010 is considered to belong in this classification.

3.0 Mean Time To Repair (MTTR)

SIL determinations are based on a number of factors, including the Mean Time To Repair (MTTR). The analysis for the Enhanced ECLIPSE Model 705 is based on a MTTR of 24 hours.

4.0 Supplemental Documentation

The Enhanced ECLIPSE Model 705 Installation and Operating Manual (57-600) must be available and used for installation of the level transmitter.

If the HART digital protocol will be used, the following Electronic Device Description Files are also required:

Manufacturer Code 0x56
Model 705 3.x Device ID 0xE5, device revision 1,
DD revision 1.

For device installations in a classified area, the relevant safety instructions and electrical codes must be followed.

5.0 Instructions

5.1 Systematic Limitations

The following must be observed to avoid systematic failures:

5.1.1 Application

As the probe configuration establishes the fundamental performance characteristics of the system, choosing the proper Guided Wave Radar probe is the most important decision in the specification/application process. Coaxial, twin element (rod or cable), and single element (rod or cable) are the three basic GWR probe configurations. The probe for use with the SIL 2/3 certified Enhanced ECLIPSE Model 705 must be selected as appropriate for the application (e.g., careful selection of probe design and materials for a specific application will minimize media buildup on the probe).

Refer to Section 3.3.3 of Installation and Operating Manual 57-600 for more detailed application information regarding media buildup and bridging.

5.1.2 Environmental

Refer to Section 3.6 of Installation and Operating Manual 57-600 for the Model 705 Environmental Specifications.

5.2 Skill Level of Personnel

Personnel following the procedures in this safety manual should have technical expertise equal to or greater than that of a qualified Instrument Technician.

5.3 Necessary Tools

Following are the necessary tools required to carry out the prescribed procedures:

- Open-wrenches or adjustable wrench to fit the process connection size and type.
  - Coaxial probe 1½" (38mm)
  - Twin Rod probe 1⅞" (47mm)
  - Transmitter 1½" (38mm)
  - Torque wrench is highly desirable
- Flat-blade screwdriver
- Cable cutter and 3/32" (2.5mm) hex wrench (7X1, 7X2, 7X5 and 7X7 Flexible probes only)
- Digital multimeters or digital volt/ammeter
- 24 VDC power supply, 23 mA minimum

5.4 Storage

The device should be stored in its original shipping box and not be subjected to temperatures outside the storage temperature (-50° to +80° C) shown in the ECLIPSE Enhanced Model 705 Installation and Operating Manual, 57-600.

5.5 Installation

Refer to the Enhanced ECLIPSE Model 705 Installation and Operating Manual 57-600 manual for the proper installation instructions.

Section 2.6.4 of I/O Manual 57-600 contains information regarding the use, changing, and resetting of the password protection function.

Section 2.6.5.1 of I/O Manual 57-600 provides menu selection items for configuration of the transmitter as a Level Only sensing device.

See Section 5.6 of this manual for configuration recommendations with respect to using the Enhanced ECLIPSE Model 705 in a SIS.

As stated in Section 2.0, this SIL evaluation has assumed that the customer will be able to acknowledge an "over or under" output current condition via the Logic Unit.

Refer to section 8.3 for Safety System Assumptions (SSA).

5.6 Configuration

5.6.1 General

The MAGNETROL Model 705 can be configured via the local LCD/keypad, a HART compatible handheld terminal or with a personal computer containing the proper HART DTM and framework program such as PACT***ware***™.

NOTE: Parameter changes should not be made through the local display and the HART interface simultaneously. This is not a safety consideration because the user of the safety device must confirm parameter changes per SSA 7. (Refer to page 13.)

5.6.2 SIS Configuration Requirements

Ensure the GWR transmitter parameters have been properly configured for the specific application and probe.

Special consideration should be given to the following configuration parameters:

FAULT: ***DO NOT*** choose HOLD for this parameter as a Fault will not be annunciated on the current loop.

PASSWORD: The Password (default = 0) should be changed to a specific value other than 0 to ensure the necessary SIS Write/Lock protection.

The following list represents the parameter configuration required for a Model 705 GWR transmitter intended to measure overall product level in a SIL 2/3 application.

Please ensure that all Probe-specific parameters are correct for the GWR probe being used.

PROBE MODEL = As indicated on probe nameplate

PROBE MOUNT = As indicated on probe nameplate

MEASUREMENT TYPE = Level Only

LEVEL UNITS = As indicated on probe nameplate

PROBE LENGTH = As indicated on probe nameplate

LEVEL OFFSET = As required by application

DIELECTRIC = As required by application. (Suggest 1.7–3 for typical hydrocarbon application)

LOOP CONTROL = Level

LOOP CONTROL MODE = Enabled

SET 4mA/SET 20mA = As required by application

DAMPING = As required by application (Default value is 1)

FAULT = As required by application (Default value is 22 mA—do not set to Hold).

BLOCKING DISTANCE = 0 inches

THRESHOLD = Fixed

5.6.3 Write Protection/Locking

Only authorized personnel should be able to change the transmitter configuration in a device installed in a SIS system. This requires setting a user password.

The ECLIPSE Model 705 is password protected with a numerical password between 0 and 255. (Default = 0 means password is disabled).

The default password must be changed so that password protection is enabled in a SIS system.

Refer to section 2.6.4 of the Enhanced ECLIPSE Model 705 Installation and Operating Manual 57-600 for additional information regarding password protection.

Ensure that an exclamation mark (!) appears as the last character on the first line of the LCD to confirm the present password has been accepted.

When alterations to the configuration are complete, ensure the menu has been write-locked with the password to prevent inadvertent changes to the device.

For this reason, the Model 705 transmitter has a timeout feature in which, after 5 minutes with no key presses, the transmitter will revert back to the scrolling default screen and a password must be used to make any additional parameter changes.

NOTE: HART interface shall be interference free assuming the end user only allows access to HART communication to trained personnel who may not make any changes to the device parameters while the device is operational in the SIF.

5.7 Site Acceptance Testing

After installation and configuration is complete, a site acceptance test should be performed to ensure proper operation. This procedure is identical to the Proof Test Procedure described in Section 6.1.4 of this manual.

Record the results for future reference. It is also recommended to document the existing transmitter configuration. Configuration Data Sheets, included at the end of the I & O Manual 57-600, can be used for this purpose.

5.8 Maintenance

5.8.1 Diagnostics and Response Times

Continuous internal diagnostics are present within the Enhanced ECLIPSE Model 705 transmitter. In the event a Fault is detected, a message will appear on the LCD and the output current will be driven to 3.6 mA or 22mA depending on how the FAULT parameter is configured.

A) Start-up Time:
   a. From application of power to normal operating mode: 4 seconds
   b. From application of power to Fault mode: 29 seconds or less (Assuming a Fault is present upon start-up)

B) Safety Response Time: 16 seconds
   a. This is defined as the time from the normal operating mode to the Fault mode upon the occurrence of a fault.

5.8.2 Troubleshooting

Refer to Section 3.3 of the Enhanced ECLIPSE Model 705 I & O Manual 57-600 for troubleshooting the various device status messages, which can be in the form of Warnings and Faults.

To assist in finding Faults should they occur, complete the Configuration Data Sheets included at the end of the Installation and Operating Manual 57-650. Be sure to include all device information, both in the working and non-working modes.

- As there are no moving parts in this device, the only maintenance required is the proof test shown in Section 5.1.
- Firmware can only be upgraded by factory-trained personnel.
- Report all Faults to MAGNETROL technical support.

6.0 Recurrent Function Tests

6.1 Proof Testing

6.1.1 Introduction

Following are the procedures utilized to detect Dangerous Undetected (DU) failures.

6.1.2 Interval

To maintain the Safety Integrity Level of a Safety Instrumented System, it is imperative that specified manual proof testing be completed at the time intervals specified. The user must select the type of inspection and the time period for these tests.

The system check must be administered to prove that the protection functions meet the IEC specification, and as important, result in the desired response of the safety system as a whole. This system check can be guaranteed when the desired alarm level height is obtained during the process operation.

If this is not practical, a suitable method of simulating the level of the physical measurement must be used to allow the level sensor to respond as if the fluid was filled above the alarm/set point level.

If the operability of the sensor/transmitter can be determined by other means (that exclude all fault conditions that may impair the normal functions of the device), the check may also be completed by simulating the corresponding output signal of the device.

6.1.3 Recording Results

"As Found" and "As Left" results of the Proof Test should be recorded for future reference.

6.1.4 Proof Test Procedure

A suggested proof test is described below. This test will detect approximately 94% of possible DU failures in Model 705-51A*-*** version of the Enhanced ECLIPSE Model 705.

Ensure that all necessary installation and site acceptance test procedures required to achieve safety are followed.

1. Bypass the safety PLC or take other appropriate action to avoid a false trip.
2. Send a HART command to force a high alarm current output to the transmitter under test, and verify that the analog current reaches that value.

   This tests for power supply problems such as low supply voltage or increased loop wiring resistance. It also tests for other possible failures in the current loop circuitry.
3. Send a HART command to force a low alarm current output to the transmitter under test, and verify that the analog current reaches that value.

   This step tests for possible quiescent current related failures.
4. Remove level from the probe. The Status parameter should say “Dry Probe” and the level reading should be equal to the value in the “Level Offset” parameter.
5. Perform a two-point calibration check of the transmitter by applying level to two different points on the probe and compare the transmitter display readings and the current level values to known reference measurements.
6. If the calibration check performed in step 5 is correct, the proof test is complete. Proceed to step 11.
7. If calibration is incorrect, remove the transmitter and probe from the process. Inspect the probe for buildup or clogging. Clean the probe if necessary.

   Perform a bench calibration check by shorting the probe (simulating level) at two different points. Measure the levels from the bottom of the probe to the simulated levels and compare to the transmitter display and current level readings.
8. If the calibration is off by more than 2%, contact MAGNETROL Technical Support for assistance.
9. If the calibration is within tolerance, the proof test is complete. Proceed to step 10.
10. Re-install the probe and transmitter.
11. Restore the loop to full operation.
12. Remove the bypass from the safety PLC or otherwise restore normal operation.

7.0 Report: Lifetime of Critical Components

Although a constant failure rate is assumed by the probabilistic estimation method, this only applies if the useful lifetime of components is not exceeded.

Beyond the useful lifetime of a component, the result of the probabilistic calculation method is meaningless, as the probability of failure significantly increases with time.

The useful lifetime is highly dependent on the component itself and its operating conditions—temperature in particular. (e.g., electrolyte capacitors can be very sensitive).

Within the Enhanced ECLIPSE Model 705, tantalum electrolytic capacitors are the limiting factors with regard to the useful lifetime of the system. The tantalum electrolytic capacitors that are used in the transmitter have an estimated useful lifetime of about 50 years.

8.0 Appendices

8.1 Model 705 SIL Values

Enhanced ECLIPSE Model 705 GWR Transmitter

SIL Values	ECLIPSE Model 705-51Ax-xxx
SIL	SIL 2
HFT	0
SFF (High Trip) SFF (Low Trip)	91.9% 90.4%
PFD_{AVG}	9.72E-04
Proof Test Interval	Annually (refer to chart below for other periods)

8.2 PFD Chart

The resulting PFD_{AVG} values for a variety of proof test intervals are displayed in Figure 2. As shown in the figure the PFD_{AVG} value for a single ECLIPSE Enhanced Model 705 with a proof test interval of 1 year equals 1.06E-03.

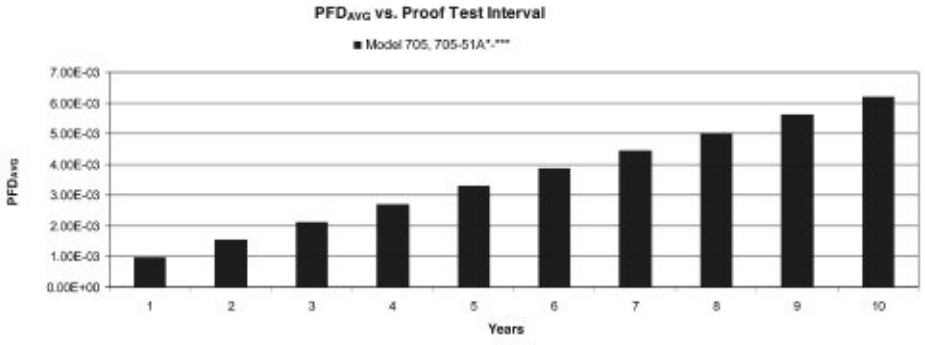


Figure 2
PFD_{AVG} Values

8.3 SSA, System Safety Assumptions

The System Safety Assumptions provide a list of safety relevant assumptions made on the usage of the product over the safety life cycle of a user Safety Integrity Function, SIF. MAGNETROL cannot directly control the user life cycle of a SIF using this product but needs to have assumptions on how the product will be used. It is important that users have full knowledge of these assumptions to ensure they are met when using the product as part of a SIF. This is to ensure the product is used in a manner consistent with the safety design.

This section only lists product specific assumptions and is not intended to specify measures required of the end user that are standard requirements for safety applications.

Identifier	Assumptions for safety	Allocated
SSA 1	The user SIF will detect and properly handle annunciation of detected fault conditions signaled by the alarm level output according to the specific requirements of the SIF.	End user's responsibility
SSA 2	Proper operation of the ECLIPSE Enhanced Model 705 3x is dependent on having 11 VDC or greater across the transmitter terminals and at least 22 mA available in the loop during normal operation.	End user's responsibility
SSA 3	A user SIF integrating the ECLIPSE Enhanced Model 705 3x current loop output will detect faulted field wiring and other faults resulting in a current loop value signal outside of the specified range and take proper actions to maintain safety integrity according to the specific requirements of the SIF.	End user's responsibility
SSA 4	Optional Local User Interface will not be relied upon by the end user SIF during normal operation and will be considered non-interfering to the safety function.	End user's responsibility
SSA 5	HART communications will not be relied upon by the end user for the SIF normal operation and will be considered non-interfering to the safety function.	End user's responsibility
SSA 6	The impact of end user configured damping values is not included in the published safety response time. (The end user must consider this as part of overall time response of the SIF)	End user's responsibility
SSA 7	The end user will independently verify all changes to end user configured parameters and validate the safety functionality prior to reliance on the product for safety protection.	End user's responsibility
SSA 8	The end user will enable the User Password to lock out any end user modifiable configuration parameters available via the Local User Interface during normal operation.	End user's responsibility
SSA 9	The end user will allow HART access only to qualified and trained personnel because access to all User Password protected parameters is allowed via HART communication without requiring the entry of the User Password.	End user's responsibility
SSA 10	The end user will have proper procedures in place to ensure safe operation over the product lifecycle.	End user's responsibility
SSA 11	The end user will ensure the device is properly installed per the product literature. The proper probe will be used for the application with the transmitter properly connected to the probe.	End user's responsibility
SSA 12	The end user must not select HOLD for the level alarm output.	End user's responsibility
SSA 13	The HART poll address must be 0.	End user's responsibility

8.4 FMEDA Report: exida Management Summary

Failure Modes, Effects and Diagnostic Analysis

Project:
Eclipse Enhanced Model 705 Guided Wave Radar Level Transmitter

Customer:
Magnetrol International
Downers Grove, IL
USA

Contract No.: MAG 09/10-39
Report No.: MAG 09/10-39 R001
Version V2, Revision R1, February 11, 2010
Griff Francis

Management summary

This report summarizes the results of the Failure Modes, Effects, and Diagnostic Analysis (FMEDA) of the Eclipse Enhanced Model 705 Guided Wave Radar Level Transmitter. A Failure Modes, Effects, and Diagnostic Analysis is one of the steps to be taken to achieve functional safety certification per IEC 61508 of a device. From the FMEDA, failure rates and Safe Failure Fraction are determined. The FMEDA that is described in this report concerns only the hardware of the Eclipse Enhanced Model 705, electronic and mechanical. For full functional safety certification purposes all requirements of IEC 61508 must be considered.

The Eclipse Enhanced Model 705 is a two-wire 4 – 20 mA smart device. It contains self-diagnostics and is programmed to send its output to a specified failure state, either high or low upon internal detection of a failure. The self-diagnostics have been confirmed using fault injection tests. For safety instrumented systems usage it is assumed that the 4 – 20 mA output is used as the primary safety variable. The unit is externally powered from 24 Volts DC.

Table 1 lists the versions of the Eclipse Enhanced Model 705 that have been considered for the hardware assessment.

Table 1 Version overview

1	Eclipse Enhanced Model 705, 705-51A*-***

The Eclipse Enhanced Model 705 is classified as a Type B[1] device according to IEC61508, having a hardware fault tolerance of 0. The analysis shows that models 705-51A*-*** have a safe failure fraction between 90 and 99% (assuming that the logic solver is programmed to detect over-scale and under-scale currents) and therefore may be used as a single device in safety instrumented functions up to SIL 2, based on architectural constraints.

The failure rates for the Eclipse Enhanced Model 705 Guided Wave Radar Level Transmitter, models 705-51A*-*** are listed in Table 2.

Table 2 Failure rates Eclipse Enhanced Model 705, 705-51A*-*, Low Trip**

Failure Category	Failure Rate (FIT)	
Fail Safe Undetected		27
Fail Dangerous Detected		861
Fail Detected (detected by internal diagnostics)	678	
Fail High (detected by logic solver)	47	
Fail Low (detected by logic solver)	135	
Fail Dangerous Undetected		141
Residual		535
Annunciation Undetected		38
External Leak		44

[1] Type B component: "Complex" component (using micro controllers or programmable logic); for details see 7.4.3.1.3 of IEC 61508-2.

Table 3 Failure rates Eclipse Enhanced Model 705, 705-51A*-*, High Trip**

Failure Category	Failure Rate (FIT)	
Fail Safe Undetected		51
Fail Dangerous Detected		861
Fail Detected (detected by internal diagnostics)	678	
Fail High (detected by logic solver)	47	
Fail Low (detected by logic solver)	135	
Fail Dangerous Undetected		117
Residual		535
Annunciation Undetected		38
External Leak		44

These failure rates are valid for the useful lifetime of the product, see Appendix A.

The failure rates listed in this report do not include failures due to wear-out of any components. They reflect random failures and include failures due to external events, such as unexpected use, see section 4.2.2.

Table 4 lists the failure rates for the Eclipse Enhanced Model 705 according to IEC 61508, assuming that the logic solver can detect both over-scale and under-scale currents.

Table 4 Failure rates according to IEC 61508

Device	λ_{sd}	λ_{su}[2]	λ_{dd}	λ_{du}	SFF
Eclipse Enhanced Model 705, 705-51A*-***, Low Trip	0 FIT	600 FIT	861 FIT	141 FIT	91.2%
Eclipse Enhanced Model 705, 705-51A*-***, High Trip	0 FIT	624 FIT	861 Fit	117 Fit	92.7%

A user of the Eclipse Enhanced Model 705 Guided Wave Radar Level Transmitter can utilize these failure rates in a probabilistic model of a safety instrumented function (SIF) to determine suitability in part for safety instrumented system (SIS) usage in a particular safety integrity level (SIL). A full table of failure rates is presented in section 4.4 along with all assumptions.

[2] It is important to realize that the "no effect" failures are included in the "safe undetected" failure category according to IEC 61508. Note that these failures on their own will not affect system reliability or safety, and should not be included in spurious trip calculations

References

- ANSI/ISA-84.00.01-2004 Part 1 (IEC 61511-1Mod) "Functional Safety: Safety Instrumented Systems for the Process Industry Sector—Part 1 Hardware and Software Requirements"
- ANSI/ISA-84.00.01-2004 Part 2 (IEC 61511-2Mod) "Functional Safety: Safety Instrumented Systems for the Process Industry Sector—Part 2 Guidelines for the Application of ANSI/ISA84.00.01-2004 Part 1 (IEC 1511-1 Mod)—Informative
- ANSI/ISA-84.00.01-2004 Part 3 (IEC 61511-3Mod) "Functional Safety: Safety Instrumented Systems for the Process Industry Sector—Part 3 Guidance for the Determination of the Required Safety Integrity Levels—Informative"

Disclaimer

MAGNETROL accepts no liability whatsoever for the use of these numbers or for the correctness of the standards on which the general calculation methods are based.

ASSURED QUALITY & SERVICE COST LESS

Service Policy

Owners of MAGNETROL controls may request the return of a control or any part of a control for complete rebuilding or replacement. They will be rebuilt or replaced promptly. Controls returned under our service policy must be returned by prepaid transportation. MAGNETROL will repair or replace the control at no cost to the purchaser (or owner) other than transportation if:

1. Returned within the warranty period; and
2. The factory inspection finds the cause of the claim to be covered under the warranty.

If the trouble is the result of conditions beyond our control; or, is NOT covered by the warranty, there will be charges for labor and the parts required to rebuild or replace the equipment.

In some cases it may be expedient to ship replacement parts; or, in extreme cases a complete new control, to replace the original equipment before it is returned. If this is desired, notify the factory of both the model and serial numbers of the control to be replaced. In such cases, credit for the materials returned will be determined on the basis of the applicability of our warranty.

No claims for misapplication, labor, direct or consequential damage will be allowed.

Return Material Procedure

So that we may efficiently process any materials that are returned, it is essential that a "Return Material Authorization" (RMA) number be obtained from the factory prior to the material's return. This is available through a MAGNETROL local representative or by contacting the factory. Please supply the following information:

1. Company Name
2. Description of Material
3. Serial Number
4. Reason for Return
5. Application

Any unit that was used in a process must be properly cleaned in accordance with OSHA standards, before it is returned to the factory.

A Material Safety Data Sheet (MSDS) must accompany material that was used in any media.

All shipments returned to the factory must be by prepaid transportation.

All replacements will be shipped F.O.B. factory.

ECLIPSE Guided Wave Radar transmitters may be protected by one or more of the following U.S. Patent Nos. US 6,626,038; US 6,640,629; US 6,642,807; US 6867729; US 6879282; US 6906662. May depend on model.

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